Appendix C

Alternatives Formulation Report (AFR)

FINAL
ALTERNATIVES FORMULATION REPORT
PROPOSED LAKE DAVIS PIKE ERADICATION PROJECT

CALIFORNIA DEPARTMENT OF FISH AND GAME

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The California Department of Fish and Game (DFG) is proposing to eradicate northern pike (*Esox lucius*) from Lake Davis to return Lake Davis to a productive trout fishery and to prevent the escape or movement of this voracious predator to downstream areas and other waters of the State and region. This Alternatives Formulation Report (AFR) describes the phases and steps the DFG took to select the reasonable range of alternatives evaluated in the environmental document for the proposed Lake Davis Pike Eradication Project. The AFR also discusses the other options considered by the DFG and the Plumas National Forest (PNF) during the alternatives formulation process that were identified by the DFG project staff, other State and federal agencies (e.g., California Department of Water Resources, United States Forest Service, Central Valley Regional Water Quality Control Board), the Lake Davis Steering Committee, and the public.

The DFG sought to develop a proposed project that would eradicate pike from Lake Davis, with the least effect on public health, the local economy, and ecological and recreational values. The DFG used the information gained in the 1997 treatment, along with advice and input from its internal experts, out-of-state pike biologists, and other experts from State and federal agencies, universities and in private firms to develop a proposed project and alternatives to accomplish the project objectives.

Background

Lake Davis is a reservoir operated by the DWR for purposes of recreation, fish and wildlife enhancement, and water supply. Pike were first observed in Lake Davis in 1994. Northern pike is a non-native, invasive fish species that was illegally introduced to California. It has the potential to seriously impact California's aquatic ecosystems. In 1997, the DFG conducted a pike eradication project involving the application of rotenone to Lake Davis and its upstream tributaries. After this treatment, pike were found again in Lake Davis in 1999. The origin of these pike is unknown. Genetic studies indicate that the current population is the offspring of the initial population, rather than a subsequent introduction from a different population from another location. It is unknown whether the current population 1) came from fish that survived the 1997 treatment, 2) came from pike that were removed from Lake Davis prior to the treatment and then later reintroduced, or 3) were a second introduction of pike from the original source. Currently, Lake Davis has a thriving population of northern pike.

Following the rediscovery of pike in 1999, the local community formed the Lake Davis Steering Committee to assist the DFG in formulating a management strategy to prevent the pike population from expanding and escaping from the reservoir. This group developed a plan titled "*Managing Northern Pike at Lake Davis, A Plan for Y2000*" (referred to as the *Y2000 Plan*). This plan outlined a series of measures that might be taken to reduce the Lake Davis pike population (DFG 2000). Since 2000, many of the *Y2000 Plan*'s measures have been used to try to control and contain the pike population within the reservoir. In spite of intensive efforts, these control and containment techniques have not been effective in controlling pike numbers or reducing the chance of pike escaping downstream outside of Lake Davis. In December 2003, the Lake Davis Steering Committee decided to seek

eradication of pike from the reservoir and requested that the DFG investigate methods to rid Lake Davis of pike.

Alternative Formulation

The formulation of alternatives for the proposed Lake Davis Pike Eradication Project was an iterative process. The DFG conducted an initial evaluation of the 33 options that had been suggested by various persons and/or agencies (DFG 2004). These options, which included both water-level control and eradication chemical agents, were described in the DFG's document titled *Lake Davis Northern Pike Eradication Options*, dated May 24, 2004 (DFG 2004). Additional options were proposed by others during the project scoping process, public comment period, and interagency consultation and coordination. The options considered included: a variety of reservoir volumes from empty (0 acre-feet) to 50,000 acre-feet, a normal summer level; seven chemical agents: seven fisheries management activities that did not include use of a chemical agent; and five options that modified reservoir and/or tributary habitat. The DFG concluded that the use of formulated rotenone, or a blend of formulated rotenone, and rotenone powder combined with a large reservoir drawdown could be a feasible, effective, and safe method for eradicating pike from Lake Davis.

The proposed options were evaluated using a two-phased assessment approach. In Phase I, the options were reviewed to determine if they would accomplish the primary objective of the project to eradicate pike from Lake Davis and its tributaries. The options that met this criterion were then evaluated in Phase II against the second level criteria, which included the following factors: protection of public health and safety; timely implementation; use of a proven, effective method; compliance with applicable laws; technical feasibility; and, minimization of environmental impacts. Once the options were evaluated against these criteria, alternatives were formulated from options that best met the project objectives. A reasonable range of alternatives was selected for full analysis in the environmental document.

The options identified through internal discussion, coordination with other agencies and public scoping were varied and creative. They included fisheries management actions and fish removal techniques, the use of a variety of chemical agents as piscicides, and a range of reservoir levels from empty to normal summertime levels. In addition, other methods were suggested to eliminate pike from the reservoir that sought to alter the habitat of the reservoir and use other non-chemical means to eradicate pike. Many of these options, however, would not achieve the primary object of eradication and many of the chemical agents suggested could not legally be used in California as a fish toxicant. The options that met the selection criteria included the use of several formulations of rotenone paired with several reservoir volumes.

The range of alternatives selected for full evaluation in the environmental document included chemical treatment at four different lake volumes: 5,000, 15,000, 35,000 and 48,000 acre-feet. Chemical treatment was considered for two different formulations of liquid rotenone for all four reservoir target volumes. At a reservoir volume of 15,000 acre-feet a fifth alternative is considered that would use both liquid and powdered formulations of rotenone with powdered rotenone used in the reservoir. A sixth alternative, complete dewatering of both the reservoir and the tributaries using mechanical measures, (i.e., non-chemical treatment) is also included in the reasonable range of alternatives for analysis in the EIR/EIS. This was in

response to public scoping comments that a "no-chemical" alternative should be considered, and to further examine its potential to meet the objectives of timeliness, technical and logistical feasibility, and minimization of environmental impacts. The seventh alternative evaluated was the no project/no action alternative, which included the present management activities conducted by the DFG and the PNF continuing into the future.

The California Department of Fish and Game (DFG) is proposing to eradicate pike from Lake Davis in order to return Lake Davis to a productive trout fishery and to prevent the escape or movement of this voracious predator to downstream areas and other waters of the State and region. In the course of selecting a reasonable range of alternatives, many options were considered. The proposed project includes actions to be undertaken by the DFG and actions to be undertaken by the U.S. Forest Service (USFS), Plumas National Forest (PNF). To meet their obligation for environmental review under the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA), DFG and PNF are preparing a joint Environmental Impact Report/Environmental Impact Statement (EIR/EIS) for the proposed project.

Both CEQA and NEPA require the consideration of a reasonable range of feasible alternatives to complete environmental review. The DFG sought to develop a proposed project that would eradicate pike from Lake Davis with the least effect on public health, local economy, and ecological and recreational values. The DFG used the information gained in the 1997 treatment, along with advice and input from internal experts, out-of-state pike biologists, other State and federal agencies, universities, and other experts in private firms, to develop a proposed project and alternatives to accomplish the project objectives.

In developing the proposed project the DFG considered the comments and suggestions from a diverse group of stakeholders including the City of Portola, Plumas County, the Lake Davis Steering Committee, and private citizens so that the needs of the local community were taken into account. The Lake Davis Steering Committee is composed of a group of local community members and leaders with participation by representatives of federal, state, and local governmental agencies, including DFG, who meet to share information and address issues regarding pike in Lake Davis. The Committee provided key input into the development of potential alternatives considered by the DFG and PNF.

This Alternatives Formulation Report (AFR) describes the steps the DFG and PNF took in the course of developing the reasonable range of alternatives evaluated in the EIR/EIS, and discusses the other options considered by the DFG and PNF during the alternatives formulation process. The options considered were identified by the DFG project staff, other state and federal agencies (e.g., Department of Water Resources [DWR], USFS, Central Valley Regional Water Quality Control Board), the Lake Davis Steering Committee, and the public.

1.1 BACKGROUND

Lake Davis is a reservoir operated by the DWR, for purposes of recreation, fish and wildlife enhancement, and water supply. The spillway elevation of the reservoir is 5,775 feet, which provides a capacity of approximately 84,000 acre-feet and a surface area of about 4,000 acres. Lake Davis is currently managed to operate well below its capacity, primarily to minimize the potential for pike escapement. Typically, the reservoir is near filled each winter

through spring by the capture of seasonal precipitation and snowmelt runoff. Maintenance of minimum downstream releases, typically ranging from 10 to 23 cubic feet per second, dependent on maximum May-June reservoir surface elevation, results in the reservoir normally losing several feet of elevation over the course of summer through fall. Independent diverters take some of this water from Big Grizzly Creek at points downstream from the dam.

Lake Davis has a thriving population of northern pike. Northern pike are a non-native invasive fish species that was illegally introduced to California. Northern pike have the potential to seriously impact California's aquatic ecosystems. It preys on other fish species, including native minnows, salmon, and trout. Currently, the pike population in California is limited to Lake Davis and its tributaries. In Lake Davis, the pike population has severely reduced the numbers of rainbow trout that have historically occupied the reservoir. The pike population in Lake Davis has steadily increased in numbers since 1999. If pike are not eradicated from Lake Davis, they will likely escape the reservoir and spread to other waters within the state (e.g., the Sacramento-San Joaquin Delta) in the near future (Moyle 2002). Mechanisms for the spread of pike include (1) release through the dam outlet works or over the spillway if the reservoir spills and (2) intentional or unintentional translocation through human mechanisms (e.g., bait buckets, live wells, and bilge water).

Once pike become established in other waters, there may no longer be options available to eradicate them; and it will be very difficult if not impossible to control their numbers and limit their distribution. Pike are prolific in nature and are able to withstand a wide range of environmental conditions as well as prey on many lifestages of native and introduced species. Because of these traits, pike are likely to have substantial adverse ecological effects if they become established in California, especially in waters of the Delta and the Central Valley. These ecological effects would likely translate into economic effects through the decimation of fisheries currently operating in the Delta and Central Valley. This would endanger other aquatic populations, further increase the burden on businesses and agricultural interests relying on the Sacramento-San Joaquin River system, and increase the difficulty of distributing water supplies diverted from the affected waterways.

Pike were illegally introduced into Frenchman Lake, near Lake Davis in the late 1980s and were first observed in 1989. These fish subsequently spread into the Sierra Valley at the headwaters of the Middle Fork Feather River. Pike were successfully eradicated from these areas in 1991 and 1992 using chemical treatment and remain absent at this time. Pike were first observed in Lake Davis in 1994. In 1997, the DFG conducted a pike eradication project through the application of rotenone to Lake Davis and its upstream tributaries. After this treatment, pike were found again in Lake Davis in 1999. The origin of these pike is unknown. Genetic studies indicate that the current population is the offspring of the initial population, rather than a subsequent introduction from a different population from another location. It is unknown whether the current population 1) came from fish that survived the 1997 treatment, 2) came from pike that were removed from Lake Davis prior to the treatment and then later reintroduced or 3) were a second introduction of pike from the original source.

Following the rediscovery of pike in 1999, the local community formed the Lake Davis Steering Committee to assist the DFG in formulating a management strategy to prevent the pike population from expanding and escaping from the reservoir. The Committee includes

private citizens and elected city and county officials. Representatives from state and federal agencies participate in meetings, share information, answer questions and address issues relating to pike in Lake Davis. This group developed a plan titled "Managing Northern Pike at Lake Davis, A Plan for Y2000" (referred to as the Y2000 Plan). This plan outlined a series of measures that might be taken to reduce the Lake Davis pike population (DFG 2000). Since 2000, many of the Y2000 Plan's measures have been used to try to control and contain the pike population within the reservoir. In spite of these intensive efforts, control and containment techniques have not been effective in controlling pike numbers or in reducing the chance of pike escaping Lake Davis. In fact, data indicate that the pike population continues to expand, despite implementation of the Y2000 Plan's measures (DFG 2003).

In December 2003, the Lake Davis Steering Committee recognized that the Y2000 Plan was not achieving its goals. The Committee decided to seek eradication of pike from the reservoir. They sent a letter to California Secretary for Resources Mike Chrisman, requesting that the DFG investigate methods to rid Lake Davis of the pike. Secretary Chrisman responded by recognizing the need for the DFG to investigate safe and effective methods of ridding the state of pike. He also acknowledged that cooperation, protection of public health, and consideration of economic issues are important to any decision to effectively deal with the pike. These concerns were shared by both the local community and the DFG.

1.2 ORGANIZATION OF REPORT

This report begins with an overview of the alternatives formulation and refinement process, including a description of the project objectives and other evaluation criteria (Section 2). The initial options and potential alternatives are described in Section 3. These are water level scenarios, eradication chemical agents, non-chemical fish management actions, and other reservoir and habitat management actions. In Section 4, the options are combined and described further. Section 5 presents the results of the Phase I evaluation of alternatives described in Section 4, which considered the ability of the option to successfully eradicate pike from Lake Davis and its tributaries. Additional criteria are applied to the alternatives from Section 5, and the results are explained in Section 6. These remaining alternatives were refined to the final six alternatives to be evaluated comprehensively for environmental impacts in the EIR/EIS.

The formulation of alternatives for the proposed Lake Davis Pike Eradication Project was an iterative process. First, information was considered from a report prepared in response to a request by the Lake Davis Steering Committee, for a list of eradication options that had been suggested by various persons and/or agencies (DFG 2004). The DFG conducted an initial evaluation of the options identified, which included continuing the "control and containment" program. It was determined that continuation of the current "control and containment" program would not accomplish the goal of pike eradication. Based on the preliminary evaluation of the initial options, the DFG concluded that the use of formulated rotenone, or a blend of formulated rotenone and rotenone powder, combined with a large reservoir drawdown could be a feasible, effective, and safe method for eradicating pike from Lake Davis. The DFG and PNF then preliminarily identified a set of potential alternatives to the proposed project, which included a rotenone formulation paired with each of four reservoir levels.

Second, comments and input on the potential alternatives and additional options were gathered from the local, state and federal agencies and the interested public during four public scoping meetings (DFG 2005) and during the scoping period following the release on September 14, 2005 of the Notice of Preparation (NOP) of an EIR and Notice of Intent (NOI) to prepare and EIS for the proposed project. The NOP and NOI outlined an initial list of alternatives that the DFG and PNF planned to consider in the EIR/EIS.

Third, the comments received during the public scoping process were evaluated and, as appropriate, options were developed into new potential alternatives or incorporated into the proposed project.

2.1 PUBLIC SCOPING

Public scoping was conducted and included preliminary identification of potential alternatives developed by DFG. The DFG, in compliance with CEQA, issued a NOP on September 14, 2005. In compliance with NEPA, the USFS published a NOI in the Federal Register (Volume 68: Number 217) on September 14, 2005. The date of publication for both the NOP and NOI signified the opening of the formal CEQA/NEPA scoping period which invited the public to offer comments on the project until public scoping ended on October 31, 2005.

Scoping is the process of early consultation with the affected public and local, state and federal agencies prior to completing a draft EIR/EIS. The State of California's CEQA Guidelines and the Federal Council on Environmental Quality's NEPA regulations provide specific guidance for scoping, which has the following general purposes:

- To identify the following to be analyzed in depth in the EIR/EIS:
  - Range of actions

  - Alternatives
  - Potentially Significant effects
  - Mitigation measures

- To bring together and consider the concerns of affected federal, state, and local agencies, the project proponent, and other interested persons.

Four public meetings were held to solicit comments from the attendees and to invite them to provide additional comments during the scoping period (DFG and USFS 2006). Two meetings were held on September 26, 2005, in Portola, California, at the Eastern Plumas Health Care Education Center. The third and fourth meetings were held in Sacramento, California, at the Radisson Hotel on September 28, 2005. Public press releases were issued to local radio, television, and print media outlets to notify the public of these meetings. Approximately 4,000 direct mailing notifications were prepared and sent to residents of eastern Plumas County. An additional 1,000 notices were sent to potentially interested parties including land owners, residents, various state, local, and federal agencies along with existing DFG and USFS contacts.

DFG and PNF staff explained the project background and justification to the attendees and presented an overview of the initial project alternatives. Participants were encouraged to present written or oral comments on the project at the meetings and additionally to provide written comments or suggest other alternatives that might meet the project objectives. Approximately 108 individuals attended the scoping meetings in Portola, and another 39 individuals attended the meetings in Sacramento.

Results of the public meetings and a summary of the verbal and written public comments received during the scoping period were presented in the DFG and USFS's document entitled *Final Scoping Report for the Proposed Lake Davis Pike Eradication Project*, dated February 2006 (DFG and USFS 2006), and the subsequent erratum dated June 2006, both of which can be viewed at http://www.dfg.ca.gov/northernpike. The DFG and USFS used the comments received to help identify and refine the range of actions, alternatives, environmental effects, and mitigation measures to be analyzed in depth in the EIR/EIS. This included the evaluation of new options or potential alternatives in the Phase I and Phase II selection process described above.

2.2 MODIFICATIONS TO ALTERNATIVES PRESENTED IN THE NOP/NOI

After the scoping period, the DFG modified some of the preliminarily identified potential alternatives to be included in the reasonable range of alternatives to be analyzed in the EIR/EIS. The modifications were made to enable a clear, discrete analysis of environmental impacts. In short, rather than presenting an alternative as a range of reservoir water levels or volumes, one level was selected. For example, the potential alternative of reservoir drawdown of 10,000 to 20,000 acre-feet volume was modified to an alternative of reservoir drawdown of 15,000 acre-feet.

2.3 OPTIONS AND ALTERNATIVES CONSIDERED

The options and alternatives considered can be divided into several types of projects or actions. One type of project is chemical treatment with a piscicide paired with reservoir drawdown. Another type is fishery management, non-chemical treatments that include: netting pike; using heat to collect and kill pike, adding pure nitrogen to the reservoir; and introducing another predator to prey on the pike. Other methods suggested relied on alteration of reservoir habitat to remove pike, such as adding carbon dioxide under the ice or adding pure nitrogen to destratify the reservoir and cause gas bubble disease. The full range of options evaluated is listed in Table 2-1. This table also provides the sources of the options considered in the process of selecting the alternatives for the EIR/EIS.

2.4 TWO-PHASE SELECTION PROCESS OF ALTERNATIVES

The options considered were evaluated using a two-phased assessment approach, which considered each of the options identified. The options were reviewed to determine if they would accomplish the primary objective of the project to eradicate pike from Lake Davis and its tributaries. The options that met this criterion were then evaluated against the second level criteria which included the following: protection of public health and safety; timely implementation; use of a proven, effective method; compliance with applicable laws; technical feasibility; and minimization of environmental impacts. Once the options were evaluated against these criteria, alternatives were formulated from the options that best met the project objectives. A reasonable range of these alternatives was selected for full analysis in the environmental document (EIR/EIS).

Table 2-1. Identification and Source of Potential Alternatives

Alternative	Source of Alternative			
	Department of Fish and Game Options Report (DFG 2004)	Identified at Public Scoping by DFG	Public Scoping Agency Comment	Public Scoping Public Comment
No Action Alternative				
No Action, Discontinue Current Control and Containment Program	X	X		X
No Action, Maintain Current Control and Containment Program			X	
Chemicals for Use as a Piscicide				
Powdered Rotenone	X	X		
Standard Formulation of Rotenone (Noxfish)	X	X		
Formulated Rotenone (CFT Legumine)	X	X		
Antimycin	X			
Copper Sulfate	X			
Chlorine	X			
Chloramime	X			
Water-Level Scenario Combined with Chemical Treatment				

Table 2-1. Identification and Source of Potential Alternatives

Alternative	Source of Alternative			
	Department of Fish and Game Options Report (DFG 2004)	Identified at Public Scoping by DFG	Public Scoping Agency Comment	Public Scoping Public Comment
Dewater Reservoir Completely, Apply Piscicide to Tributaries for 1 Year, and Close Reservoir to Public for Few Years				X
Lower Reservoir to Lowest Level, Apply Piscicide to Remaining Water for >1 Year, and Apply Rotenone to Tributaries (to their source)				X
Minimum Pool, Apply Piscicide to Remaining Water and Tributaries, and Place Barriers Above and Below Lake				X
Minimum Pool, Apply Piscicide to Remaining Water and Flowing Tributaries	X	X	X	
Drawdown to 5,000 AF, Apply Piscicide to Remaining Water and Flowing Tributaries	X			
Drawdown to 20,000 AF, Apply Piscicide to Remaining Water and Flowing Tributaries	X	X	X	X
Maintain 55,000 AF, Apply Piscicide to Remaining Water and Flowing Tributaries	X	X		
Water-Level Scenario Combined with Non-Chemical Treatment				
Dewater Reservoir and Tributaries Completely	X	X		X
Dewater Completely and Screen Inlets and Outflow, Refill in Spring				X
Lower Water Levels During Spawning; Net or Electrofish to Get Pike Out				X
Other Alternatives with Non-Chemical Treatment				
Destratify Reservoir by Adding Pure Nitrogen into Bottom of Reservoir			X	
Alter Aquatic Habitat by Increasing Nutrient Load	X			
Add Carbon Dioxide Under Winter Ice	X			
Alter Aquatic Habitat of the Entire Reservoir				X
Increase Current Pike Management Methods of Control and Containment				X
Introduce Another Predator Fish				X
Attach Capsules to Prey Fish With :				X

Table 2-1. Identification and Source of Potential Alternatives

Alternative	Source of Alternative			
	Department of Fish and Game Options Report (DFG 2004)	Identified at Public Scoping by DFG	Public Scoping Agency Comment	Public Scoping Public Comment
Poison				X
Anesthetic				X
Sterilizer				X
Intestinal Blocker				X
Net Spawning Females				X
Use Navy Whale Killing Sonar				X
Use Heat to Gather Pike and Kill Them				X
Fish-Out Alternatives:				
Fish Tournament with No Restriction on Size, Quantity, Age, and Sex of Pike				X
Hold Fish Derbies with Bounties				X
Hold Fish Derby Contests for Most Pike Caught, Largest Pike Caught, Smallest Pike Caught				X
Hold BBQ's with Free Pike on Menu				X
Hold "How to Fish for Pike" Clinics				X
DFG Announce Free Fishing for 30 Days and Then Drain the Reservoir				X
Place a Bounty on Dead Pike Carcasses				X
Fish Out the Lake and Use Pike as Fertilizer				X
Fish Out the Lake and Introduce Catfish to Eat Young Pike				X
Hold a Spearfishing Contest				X

2.4.1 Phase I Assessment of Potential Alternatives

During Phase I, the DFG evaluated each potential alternative (or option) to establish whether it had the potential to meet the primary objective of successfully eradicating pike from Lake Davis and its tributaries. If the potential alternative could not achieve the objective, then it was eliminated from consideration for inclusion in the reasonable range of alternatives to be analyzed in detail in the EIR/EIS. If a potential alternative met this basic objective for Phase I, or more information was required to make this determination the potential alternative moved onto the Phase II evaluation.

2.4.2 Phase II Assessment of Potential Alternatives

During Phase II, each remaining potential alternative was assessed to determine if it met the following project objectives:

- Can be used in a manner that protects public health and safety;
- Can be implemented quickly to reduce the ongoing risk that pike will escape the reservoir and spread to other waters;
- Is a method that has been proven to be effective in laboratory and field experiments;
- Is in compliance with applicable laws;
- Is a method that is technically feasible to carry out; and
- Minimizes environmental impacts or mitigation can reduce the impact to "less than significant."

These objectives (evaluation criteria) are described in more detail below. If more information was needed to evaluate the options against a particular criteria, it was noted. If the option met the remaining criteria, additional information was obtained to complete the evaluation process. If it failed to meet one of the secondary criteria it was removed from further consideration. Exceptions to this was failure to meet the last criterion of minimizing environmental impacts or if more information was required to determine whether a criterion was met. Options were not eliminated if minimizing environmental impacts was the only criterion not met, because the environmental consequences and mitigation measures would be fully evaluated in the environmental document.

2.4.2.1 Protects Public Health and Safety

This objective addresses the safety of the general public and the people conducting the project implementation. Protection of public health includes consideration of potential impacts to air quality, drinking water and other exposure pathways in which people could be exposed to hazards. Options that posed substantial risks to public health and safety were eliminated from further consideration. For example, if a potential alternative involves a chemical agent, there must be measures to determine whether the chemical agent will be safe and legal to use.

2.4.2.2 Can be Implemented Quickly

The selection of a potential alternative that can achieve pike eradication quickly is an important objective. The pike population in Lake Davis has steadily increased in numbers since 1999, and anglers are increasingly catching more pike. If the pike are not eradicated promptly, there is a strong likelihood they will spread or be moved to other waters of the state or region, including downstream locations and into the Sacramento-San Joaquin Delta, and result in negative impacts on California's aquatic ecosystems. In May 2006, a check of recreationists leaving Lake Davis showed that live pike were being transported out of the area. In addition, electrofishing in June of 2006 found young-of-the-year pike in and around the dam. This is the first time small pike have been caught near the dam. Currently, the pike population in California is limited to Lake Davis, which presents a window of opportunity to eliminate them. The control and containment management techniques used for the last

several years have not been effective in eradicating pike or in reducing the chance of pike escaping downstream or being moved outside of Lake Davis.

Alternatives using non-permitted chemicals that could be safely applied from a human health perspective were considered. In order to use these chemicals, the California Department of Pesticide Regulation (CDPR) would need to approve them for use as a piscicide in California (see section 2.2.2.4 below). However, after consultation with the CDPR, it was determined that these alternatives could not be implemented quickly because such alternatives could only be implemented after significant information was gathered and changes in governmental regulation and policy, permitting, or listing had occurred. Such changes would likely take many years. In the light of the ongoing risk of pike escapement, such a delay is considered inconsistent with the project objective of prompt implementation.

2.4.2.3 Proven Effective in the Laboratory and Field

The eradication method must be proven by laboratory and field tests to be an effective method of eradicating northern pike. The method selected should not be experimental or a new application. Using a method with demonstrated effectiveness dramatically increases the opportunity for successful application and achieving the desired objective.

2.4.2.4 Compliance with Applicable Law

The eradication method must comply with applicable law. For example, an eradication agent, such as a piscicide (fish-killing agent), must be legally permitted for use in California. The piscicide must also be registered with the U. S. Environmental Protection Agency (USEPA) and CDPR. Eradication agents which have not been analyzed by and registered with the USEPA and CDPR have not undergone an extensive evaluation to determine their effectiveness in killing, nor have the human health and safety issues related to their use been fully explored. Based on this and the length of time required to achieve registration, unregistered chemicals were removed from further consideration.

2.4.2.5 Technically Feasible to Implement

The eradication method must be technically and logistically feasible to carry out.

2.4.2.6 Minimize Potential for Environmental Impacts

The process of eradicating pike would have environmental impacts. Some of these impacts include the loss of recreational use, adverse impacts to other aquatic organisms, plants and wildlife, and possible impacts to cultural resources. The eradication method should not result in dramatic, adverse environmental impacts that cannot be mitigated to reduce their significance.

This objective was not used by itself to eliminate potential alternatives, because the extent of environmental impacts will be analyzed in the EIR/EIS. The EIR/EIS provides a more thorough basis for evaluation of the benefits of an alternative in light of its environmental risk (or benefit) and allows comparison of the environmental effects of the various alternatives.

As part of the process to develop viable alternatives to eradicate pike from Lake Davis and its tributaries, the DFG compiled an initial list of options that, either together or combined with other options, would represent potential alternatives (DFG 2004). In addition, other options identified by the DFG, by other agencies, or by the public prior to or during public scoping were considered. These additional options primarily included reservoir and fisheries management options. The range of options is described below.

3.1 ERADICATION CHEMICAL AGENTS

The DFG examined seven chemical agents that could be used to eradicate pike. The use of activated carbon, which is not known to be an eradication agent, has also been included for discussion in this section to address a suggestion received during the public scoping process.

3.1.1 Powdered Rotenone

The powdered form of the piscicide rotenone (produced from the roots of tropical legumes such as *Derris* spp. and *Lonchocarpus* spp.) is a proven and feasible method for eradicating fish in standing water. In areas where the source plants occur naturally, rotenone has been used historically to kill fish. In the United States, it has been used in fishery management since the 1930s.

Powdered rotenone can have limited effectiveness in moving water such as streams and creeks; only standing water application is described on the label. Registered for use as a piscicide with the USEPA and the CDPR, powdered rotenone has undergone extensive laboratory and field-testing and has explicit directions for use. If used according to label instructions, both the USEPA and the CDPR have determined the product to be safe for workers and the general public. Powdered rotenone is extremely toxic to organisms that obtain oxygen through gills. If the powder is inhaled into the lungs of other animals it can also be toxic. The powdered form of rotenone is not as effective in distributing both horizontally and vertically in water as are the liquid formulations. It readily biodegrades in water via oxidation and in light via photolysis.

3.1.2 Standard Formulated Rotenone (e.g. Noxfish®)

Standard liquid formulations of rotenone (for example, Noxfish) are a proven and feasible method for eradicating fish in both standing and flowing water. Registered for use as a piscicide with the USEPA and the CDPR, the Noxfish formulation has undergone extensive laboratory and field-testing and has explicit directions for use. The formulation consists of rotenone extract dissolved into solvents and emulsifiers, which help it mix into water and disperse both horizontally and vertically, even through thermoclines.

According to the Noxfish label, the product contains aromatic hydrocarbons as part of the solvent system. By definition, aromatic hydrocarbons are volatile and do not remain in water

for long. These compounds, particularly naphthalene, have a strong odor, which was noticed by nearby residents during the 1997 treatment using Nusyn-Noxfish®.

Some rotenone formulations (for example, Nusyn-Noxfish) use a smaller amount of rotenone with a pesticide synergist, piperonyl butoxide. The piperonyl butoxide is far less toxic than rotenone, but reportedly it makes the rotenone more effective so that less rotenone is needed to get the same effect. When Lake Davis was treated with Nusyn-Noxfish in 1997, this compound did not biodegrade as readily as the other compounds. It was detected at the part per billion level in the deepest sampling station in Lake Davis for about seven months following the October 1997 treatment. Nusyn-Noxfish is not under consideration for this project.

With the exception of the synergist piperonyl butoxide, rotenone is the most persistent chemical in the standard liquid formulation. Rotenone itself readily decomposes in water (oxidation) and light (photolysis). Standard formulations of rotenone may contain other ingredients, which are proprietary information and, therefore, may not be listed on the label. All ingredients, however, were disclosed to the USEPA and CDPR and taken into consideration when the product was registered and the label instructions developed.

3.1.3 Alternative Formulated Rotenone (CFT Legumine)

About 15 years of research and development have resulted in an alternative rotenone formulation that is currently being used in Europe. Its effectiveness has been demonstrated in the laboratory and in the field. According to scientists working on this formulation, the formulation uses diethylene glycol ethyl ether, 1-methyl-2-pyrollidone and a fatty acid ester to improve the rotenone's ability to dissolve into water. As with the traditional formulation of rotenone, the solvents and emulsifiers break down rapidly. The product has a faint odor. The CFT Legumine formulation of rotenone is registered for use by the USEPA and is registered by CDPR as CFT LEGUMINE (655-805-AA-75338). During monitoring of field trials in the United States, rotenone was the most persistent chemical in the formulation.

3.1.4 Antimycin

Antimycin (an antibiotic drug) has undergone extensive laboratory testing and field use as a piscicide, and is both a feasible and effective method to kill fish in flowing and standing waters. It has been used primarily in reservoirs up to about 15 to 20 feet deep and not more than 30 feet deep according to some accounts/reports. However, antimycin is not effective in deep reservoirs such as Lake Davis, which would still have a depth of about 68 feet at 5,000 acre-feet, or in water with pH values greater than or equal to 8.5. Since the pH of Lake Davis can exceed 8.5, it is probably not appropriate for use in that environment.

Antimycin is registered for use as a piscicide by the USEPA. In the past Antimycin was registered for use in California. However, antimycin is not currently registered with the CDPR due to a lack of human health and safety data. Assuming that sufficient funds were made available to develop the required health and safety data, it typically takes approximately one year once the data has been submitted to the CDPR for the registration process to be completed. Based on conversations with representatives of the CDPR, emergency exemptions are possible in some cases. However, due to the expense and time

requirements of obtaining the required data, it is not anticipated that the product will be registered for use in California in the near future, and especially not in a timely manner that could meet a desired implementation schedule for Lake Davis. Antimycin was removed from further consideration for use in Lake Davis to eradicate pike based on uncertainties about its effectiveness in Lake Davis and its status as an unregistered piscicide in California.

3.1.5 Copper Sulfate

Copper sulfate is toxic to fish and a variety of other aquatic organisms including plants, but does not have a history of use specifically as a piscicide and is not registered for use as a piscicide by the USEPA or the CDPR. In aquatic systems, copper sulfate has been used mainly as an algaecide. The DFG did not find any examples of copper sulfate being used specifically as a piscicide, or any laboratory or field tests of its effectiveness. While it is very soluble in water, it does not volatilize. Instead, the copper tends to bind to sediments, and persists in the environment for extended periods. Its use could result in copper build-up in the sediments leading to a sterile bottom. The European Union (EU) proposed a complete ban on all copper use, which was scheduled to take effect in May 2002, due to environmental concerns about excessive copper buildup in soils. For these reasons, copper sulfate is not being considered for application.

3.1.6 Chlorine

Chlorine (in the form of hypochlorite, the same agent used in laundry bleach) is highly toxic to fish at levels that are safe for humans. It has been used since the 1900s to disinfect drinking water and treat wastewater. When chlorine is added to water with organic content, hazardous byproducts such as trihalomethanes are produced. Chlorine generally dissipates from water in a few days. Chlorine kills fish, crustaceans, amphibians, reptiles, mollusks, gastropods, algae, plants, and plankton. Chlorine has been used in fish eradication projects. It is not registered for use as a piscicide by the USEPA or CDPR and so is not being considered for application to Lake Davis.

3.1.7 Chloramine

Chloramine, which is caused by the reaction of chlorine and ammonia, has been used for drinking water treatment since the 1930s. Chloramine does not result in the formation of as many trihalomethanes as chlorine, but is persistent in water and requires removal with carbon-activated filters. The DFG did not find any examples of chloramine being used as a piscicide. Chloramine kills fish, crustaceans, amphibians, reptiles, mollusks, gastropods, algae, plants and plankton. Chloramine is not registered for use as a piscicide by the USEPA or CDPR and so is not being considered further for application to Lake Davis.

3.2 WATER-LEVEL SCENARIOS

Initially the DFG evaluated several different water levels in the reservoir to determine the effectiveness and duration of the pike eradication project. Water levels considered ranged from an empty reservoir to a typical summer water volume, 55,000 acre-feet.

3.2.1 Complete Dewatering of the Reservoir

This scenario includes the complete dewatering of Lake Davis without the use of a chemical eradication agent, such as rotenone. Big Grizzly Creek provides year-round inflow into the reservoir. If Lake Davis were completely dewatered, Big Grizzly Creek along with Cow Creek and Freeman Creek may continue to flow into Lake Davis. A complete dewatering project would need to address eradication of pike remaining in these creeks and manage the inflow from these creeks to bypass the reservoir. In addition, the lowest valve in Grizzly Valley Dam would leave a small pool (about 11 surface acres) above the dam. A method to remove the remaining 107 acre-feet of water (about 34.5 million gallons) would need to be employed. (*See* Section 3.5.4 for a discussion of pumping.)

3.2.2 Partial Draining

Partial draining of Lake Davis is technically feasible and could be combined with an eradication agent to remove pike from the remaining waters. The DFG estimated the time it would take to drain down the reservoir to various levels and then refill after treatment by looking at historical inflow records for 1967 through 2004. The reservoir levels initially evaluated by DFG included minimum pool, 5,000 acre-feet, 20,000 acre-feet, and 55,000 acre-feet (DFG 2004). Using the hydrologic model, DFG found that reservoir levels of 20,000 acre-feet and 55,000 acre-feet could usually be reached within one season, but reservoir levels of 5,000 acre-feet or lower would require two or more years to reach these levels. These reservoir levels formed the basis of the alternative water volumes that were eventually refined to the alternatives considered in the EIR/EIS: 5,000 acre-feet, 15,000 acre-feet, 35,000 acre-feet and 48,000 acre-feet. The paring of chemical agents with reservoir drawdown is discussed in Section 4.0

3.3 FISH MANAGEMENT OTHER THAN CHEMICAL AGENT APPLICATION

The DFG evaluated several fish management options, most of which were received during the public scoping comment period. These fish management options are described below. Many were not effective means of attaining the primary objective of the project, which is eradicating pike from Lake Davis and its tributaries, and so were not considered further.

3.3.1 Net or Electrofish to Get Pike Out

The use of netting and electrofishing are currently being used at Lake Davis as part of the fish management practices under the control and containment strategy. These options were raised as potential alternatives at the public scoping meetings. Gill and trammel nets are used to capture fish, particularly in potential spawning areas, to capture larger spawning pike. Also, various types of electrofishing equipment are used to collect northern pike from Lake Davis and its tributaries. Electrofishing has been concentrated in the near shore areas because it is only effective at catching fish in shallow water. Electrofishing at Lake Davis has been conducted using a boat, while sampling of Grizzly, Freeman and Cow creeks, and other tributaries has been conducted using a backpack electrofisher. This technique will help to control and contain the pike but it will not eradicate the pike.

3.3.2 Net Spawning Females

The DFG currently uses trap nets placed in shallow areas to net spawning females. The concept of netting spawning females to eradicate pike from Lake Davis was also received from the public during the public scoping meetings, but not described in detail. For the purposes of this analysis, the DFG assumed that the commentor believes that using nets to catch spawning females, if implemented sufficiently, would result in the eradication of pike from both Lake Davis and its tributaries. The concept appears to be that spawning pike tend to be found in shallow weedy areas and therefore could be captured when they are in a concentrated and vulnerable state. This technique will help to control and contain the pike but it will not eradicate the pike.

3.3.3 Introduce Another Predator Fish

This concept has been recommended to the DFG numerous times since 1998 and again during the public scoping meetings. The concept would entail introducing a predator higher in the food chain than pike into Lake Davis to eat pike and hopefully eliminate pike. Many suggestions have included using muskellunge, otters, alligator gars, brown trout and other species of predators. In addition, it was suggested that catfish be added to eat young pike in association with a fish-out method.

This concept does not solve the problems that pike pose to Lake Davis and the state and regional aquatic ecosystems. Instead it compounds the problem by introducing yet another non-native, voracious predator. Furthermore, there is no evidence that adding a larger more aggressive predator would eliminate pike. It is likely that introducing a new predator would only increase the level of threat to native and downstream fish and wildlife resources, rather than protect them. While there is a possibility that a new predator (as yet unidentified) could eliminate or control pike in Lake Davis, there are no known instances where this has occurred and there would be a substantial risk that the new predator would then replace pike as the threat to the same fish and wildlife resources that the DFG set out to protect. Introducing a higher predator fish to Lake Davis would likely only worsen the existing situation.

3.3.4 Attach Poison-Containing Capsules to Pike Prey Fish in Lake Davis

This concept was received as a comment from the public during the scoping meetings. According to its author and inventor (patent pending status), prey fish of pike would be captured and attached with a capsule and released back to the waters in which they came. The capsule could be filled with an anesthetic, poison, sterilizer or intestinal blocker that would then be eaten by pike (or any predator fish).

It is estimated that the current population of pike in Lake Davis is in the hundreds of thousands. Therefore, at least that many prey fish would need to be captured and fitted with capsules in order to eradicate pike. The probability of every pike eating at least one prey fish with a poison capsule is very low. The author/inventor of this technique also states that this method is not an eradication method, but could be employed as a control method.

It would be impractical to capture enough prey fish to fit with poison capsules and expect that each could be eaten by pike and resulting in eradication, or even a high level of control.

It would be more efficient to expend the same (or greater) effort to capture pike directly and remove them from the reservoir. However, as demonstrated by the DFG's several-year effort to capture pike with nets and electroshocking, the population of pike continues to grow in spite of the large numbers of pike that are removed. As such, any efforts to capture the prey of northern pike and then attempt to eradicate pike indirectly would be futile.

In addition, there are concerns about non-target species coming in contact with the poison or other items in the capsule. If a prey species were to be picked up from the lake or die and wash up on shore it could be picked up by wildlife, people (including children) or birds. These non-target groups could be exposed the items in the capsules and additional adverse impacts could occur.

3.3.5 Use Navy Whale Killing Sonar

The concept of using sonar to control or eradicate pike from Lake Davis was received from the public during the scoping meetings.

High intensity sonar is used by the U.S. Navy for detection of submarines and for other military applications. High intensity sonar is also used by geotechnical companies for locating petroleum resources in the marine environment. High intensity sonar is emitted at a minimum of 235 decibels and can affect several hundred square miles of ocean. In water, sound travels farther and has a more substantial impact on live organisms than in air. Information compiled by the Natural Resources Defense Council indicates that high intensity sonar is responsible for numerous deaths of marine mammals, mainly whales, dolphins and porpoises. The sonar affects the mammals in such a way that either causes internal auditory and navigational disorders so that the animals either bleed to death or are so disoriented that they become stranded on-shore or are eaten by predators.

After much effort, the DFG did not find any literature that describes the direct effects sonar might have on fish. There are reports that some fish have been found dead in areas of high intensity sonar use, but live fish also occur in the area. If sonar has similar effects on fish as explosives and other sound-making devices, then there could be opportunities for developing sonar for use as a method to control or kill fish in the future. However, at this time, not enough is known about sonar to consider using the technology for pike eradication. Development of sonar for use as a pike eradication option would likely take longer than the project timeline would allow, and its ultimate applicability is unknown. It also appears that not all fish may be affected, and this might be more of a control and containment rather than an elimination method. This method probably would not work in the streams. This option was not considered further.

3.3.6 Use Heat to Gather Pike and Kill Them

This concept was received as a comment from the public during the scoping meetings. However, this concept was not adequately described to allow a thorough analysis of its potential use in eradication of pike from Lake Davis. For the purposes of this analysis, the DFG assumed that the commentor believes that a discharge of heated water into the reservoir and its tributaries might attract pike to a location(s); then various methods would be employed to capture or kill the fish. By itself, this is not a proven effective method for

eradicating pike. However, using heated waters to attract pike could possibly be employed in combination with a proven eradication method to help control the population. It is not likely that this method would attract all the pike and thereby result in eradication of pike from the reservoir.

3.3.7 Various Fish-Out Pike Options

Various options to "fish-out" or angle for pike were received from the public over the last decade as well as during the public scoping meetings and during the public scoping period. The range of fish-out options include offering bounties and other incentives to anglers, conducting derbies, holding spearfishing events, as well as hiring a commercial fisher to remove or eradicate pike. Specific suggestions included:

- Fish tournament with no restriction on size, quantity, age, and sex of pike;
- Hold fish derbies with bounties;
- Hold fish derby contests for most pike caught, largest pike caught, smallest pike caught;
- Hold BBQs with free pike on menu;
- Hold "how to fish for pike" clinics;
- DFG announce free fishing for 30 days and then drain the reservoir;
- Place a bounty on dead pike carcasses;
- Fish out the reservoir and use pike as fertilizer;
- Fish out the reservoir and introduce catfish to eat young pike; and
- Hold a spearfishing contest.

There are case studies that have shown that populations of fish can be severely depleted, over-fished, or over harvested, but never completely eliminated. Using anglers to catch all the pike in Lake Davis in the time frame needed and achieve a 100 percent removal is unlikely. Pike are not vulnerable to conventional fishing techniques until after about two years of age; thus, mostly larger pike would be targeted and caught while the smaller more numerous pike would remain. If after a season of intensive fishing, only a few spawning sized adult pike were to remain, the population would continue to survive and reproduce. Years of intensive fishing (using all combinations of public angling, derbies, bounties, and angler incentives and commercial fishing) in Lake Davis could depress the population, but would not assure that all fish are removed. Additionally, the longer that the population is allowed to persist increases the possibility that pike could eventually escape. Moreover, the concept of people fishing pike out of Lake Davis itself increases the risk that pike will be moved to other waters, including downstream to the Sacramento-San Joaquin Delta. In 2006, wardens found live pike being transported from Lake Davis by anglers.

These options were eliminated because they were determined not to be effective at eradicating pike. Most of these alternatives are fish management alternatives (e.g., fish-out alternatives that may impact the pike population temporarily, but were not likely result in pike eradication). Because fish management measures currently being employed at Lake Davis have not been effective to date, it is unlikely that similar methods would have significantly more success.

3.3.8 Increase Current Pike Management Methods of Control and Containment

This concept was raised during the public scoping period. As described in Section 3.0, the existing control and containment efforts by the DWR and DFG include structural retrofits to the dam outlet, water level control, increased enforcement, and mechanical removal of pike. These actions represent the highest level of control and containment of pike in Lake Davis within existing technological, legal, and political parameters. Increasing the level of mechanical removal effort could result in a reduction of the pike population, but not eradication. It appears unlikely that any additional effort would result in the desired objective of complete eradication. The commentor did not identify any other components of this alternative.

After the DFG published its *Y2000 Plan* (DFG 2000), all of the actions contained in that report were implemented. These actions represent the highest level of control and containment of pike in Lake Davis within existing technological, legal and political constraints. To date, these efforts have helped in keeping pike from escaping to downstream waters. These same efforts however, have yet to demonstrate that the population of pike can be completely eradicated. In fact, despite these efforts by the DWR and DFG, the pike population continues to grow and anglers are increasingly catching more pike out of Lake Davis. In addition, this year, even with major efforts by the DWR the reservoir came within 27 inches of spilling as a result of extremely wet weather conditions.

Increasing the level of mechanical removal effort could result in a reduction of the pike population, or at least a reduction in the population growth rate, but not eradication. Similarly, an increase in fines or other enforcement does not result in any more assurance that pike will not be illegally transported in or out of the reservoir. The DFG recently discovered that anglers are moving live pike out of the reservoir. The dam outlet is currently being retrofitted by the DWR to increase the efficiency of killing pike if they pass through the discharge, but these efforts do not eliminate pike from the reservoir or its tributaries.

Control and containment efforts will not eliminate pike. Despite the implementation of control and containment measures and experimental procedures from 2000-2002, a 10-fold increase in the pike catch rate has occurred. This suggests that the pike population in Lake Davis has expanded during that time. Continued use of these control measures is inadequate to compensate for pike fecundity. Compensatory reproductive mechanisms result in higher survival of young pike when the population is depressed. Therefore lowering the population results in higher survival of the young-of-the-year fish. This option did not meet the primary project objective.

3.4 RESERVOIR/HABITAT MANAGEMENT

3.4.1 Place Barriers/Screen Below and Above Reservoir

Barriers below the reservoir consist of fish graters installed on Grizzly Valley Dam outlets, built by the DWR to impede the passage of adult pike from the reservoir to the Big Grizzly Creek downstream of the dam. In addition, the dam outlet is currently being retrofitted by the DWR to increase the efficiency of killing pike if they pass through the discharge. This option would be to maintain or improve these barriers. Barriers below the reservoir do not eliminate pike from the reservoir or its tributaries.

Above the reservoir, several bar rack barriers have been installed on Big Grizzly, Cow and Freeman Creeks to try and prevent pike movement further into upstream tributaries. The concept of barriers or screens separating the reservoir and its upstream tributaries is an option that could be used in concert with other pike eradication options. If a concurrent treatment (chemical or non-chemical) of the tributaries is not feasible or needed, barriers/screens to upstream fish movement would be located, designed, or constructed as needed to prevent pike from moving up into the streams from the reservoir. If the reservoir were chemically treated, all water from the barriers to the reservoir would be treated to help ensure that no pike survive the treatment. Monitoring has determined that these barriers have not been effective in preventing upstream movement of pike during high runoff years. DFG has recently found pike above two barriers installed on Grizzly Creek and upstream are on cow creek upstream of Lake Davis ((I. Paulson, pers. comm., 2006).

3.4.2 Destratify Reservoir by Adding Pure Nitrogen into Bottom of Reservoir

This concept was raised in a written public scoping comment. Based on the written comment and a subsequent telephone interview (with Schladow – personal communication with R. Kelly), this concept includes bubbling nitrogen from the bottom of the reservoir or within the hypolimnion (colder, less oxygenated water level) to artificially destratify or "turnover" the reservoir. The release of nitrogen at or near the bottom of the reservoir would have the effect of saturating the water with nitrogen and potentially replacing or reducing the dissolved oxygen even further. The objective would be to kill pike by saturating the water with nitrogen or by depleting the oxygen content throughout the water column.

The process would require that large quantities of compressed nitrogen be forced through aeration manifolds or air stones placed at or near the bottom of the reservoir. The rising bubbles would, in effect, draw the hypolimnetic waters upward and through the thermocline and thus mix with the oxygenated waters of the epilimnion. Such a method would require thousands of strategically placed nitrogen release points throughout the reservoir bottom. The bubbling of the nitrogen could require several days or weeks to fully mix the hypolimnetic and epilimnetic waters. It is not known specifically how much nitrogen would be required or how well, if at all, the nitrogen would saturate or replace the oxygenated waters. Fish could potentially suffer the bends (a condition whereby nitrogen becomes dissolved in the tissues of the organism) or die from the lack of oxygen.

Destratification of the reservoir occurs naturally each year, yet no major fish kills happen as a result. Therefore, it is likely that nitrogen saturation would be the significant factor in any killing of fish. No data exists to fully demonstrate that nitrogen-saturated reservoir water

would eliminate northern pike. Additionally, this concept does not address the use of nitrogen in the tributaries where pike are known to exist. The commentor has indicated that all fish might not die, and crews would have to be on the lake to pick-up distressed fish. In addition, it is unlikely that all oxygen would be displaced, especially in the shallows where it would be hard to get nitrogen distributed, and wind action would be continually re-oxygenating the water.

This methodology has no record of laboratory or field use. It does not appear to be an eradication option, since it would not necessarily kill all pike. In addition, the introduction of nitrogen as a piscicide would require registration by the CDPR. Nitrogen is not registered for use in California as a fish toxicant and therefore was not considered further.

3.4.3 Alter Aquatic Habitat by Increasing Nutrient Load

This concept is discussed in the DFG's report *Lake Davis Northern Pike Eradication Options* (DFG 2004), dated May 24, 2004 and it was brought up in scoping comments. The basic premise is to increase the nutrient load by adding tens of thousands of tons of nutrients in the form of corn syrup, molasses, fertilizer, or methanol alcohol, such that the biological oxygen demand (BOD) resulting from bacteriological breakdown of the nutrients depletes the available oxygen to lethal levels. Based upon information provided by a firm that has conducted this type of work and a subsequent follow-up meeting with CDFG, this process was used in a Wyoming open pit mine to eliminate uranium and selenium with metal-reducing bacteria enhanced by the nutrient loading. The method was not used to eradicate fish. The experts who used this method thought that it *might* help solve the pike problem. However this method has not been laboratory or field tested for use as a tool for killing fish and several questions remain unanswered as to its ability to fully eradicate pike. In addition, the associated impacts on ecological processes remain a concern. For example, there is no data that would suggest that all oxygen could be eliminated and what would be the optimum conditions under which we could achieve the stated objectives. Furthermore, how could such a methodology be applied to flowing waters and how would that same inflow to the reservoir affect the objective of keeping the BOD in the reservoir high enough to kill pike? The associated environmental impacts, health risks, persistence, aesthetics, taste and odor issues are all unknown at this time. The materials are not approved for use as a piscicide in California. The method may also violate Clean Water Act and/or Regional Water Quality Board regulations.

Although more research and documentation could lead to consideration of this option for fish control in the future, it remains untested and thus provides no assurance that it would eradicate pike from Lake Davis and its tributaries.

It is also unlikely that the oxygen level in the shallows would be reduced significantly enough to kill pike due to wind action re-aerating the shallows and the ability of pike to survive in low oxygen water. Due to the uncertainties of achieving eradication and the lengthy time frame required to investigate and resolve the issues described above, this method was not considered further.

3.4.4 Add Carbon Dioxide under Winter Ice

This concept is briefly described in the DFG's report *Lake Davis Northern Pike Eradication Options* (DFG 2004), dated May 24, 2004. The use of bubbled carbon dioxide (CO_2) as a potential pike control method was also submitted as a Merit Award Suggestion (No. 2000–05).

This concept involves the introduction of large quantities of CO_2 under the reservoir's winter ice cover. The high levels of CO_2 would raise water acidity, inhibiting pike growth and reproduction. This method is potentially technically feasible. It would send carbon dioxide gas to the bottom of the reservoir or any level in the water column using air hoses, compressors, and air release manifolds suspended or stabilized with floats, weights, or shoreline-tethered devices. "Release sites" would be strategically placed throughout the reservoir to enable even and maximum distribution of the bubbled CO_2. If the gas were to be bubbled under the ice, the device(s) would have to be set up in late fall or early winter prior to ice formation on the reservoir. It is unknown how much carbon dioxide would be required and how long the bubbling of gas would take.

According to the limited literature provided in the Merit Award Suggestion, the CO_2 gas would reduce the available oxygen and thus kill fish with anoxic conditions. According to the same literature source, the addition of CO_2 would result in unfavorable water quality conditions by raising the acidity of the water. CO_2 is used as a fish anesthetic in fishery science and hatchery applications where the use of carcinogenic chemicals is no longer allowed. Prolonged use of bubbled CO_2 in these controlled situations does, on occasion lead to accidental death of fish. CO_2 diffuses quickly in water and air and thus the residual effects could be short term.

This method would probably not work in the streams, as the flowing water would re-oxygenate quickly, and it would be almost impossible to get the carbon dioxide into all the undercut banks and to create anoxic conditions in some of the heavy vegetation mats.

This method lacks adequate laboratory testing on its effectiveness and feasibility, lengthy field trials, and a proven record of successful use for fish eradication on a scale comparable to Lake Davis. In addition, CO_2 is not registered by the USEPA and CDPR as a piscicide. This option was not considered further.

3.4.5 Alter Aquatic Habitat of the Entire Reservoir

This idea was received during the scoping period. No specific details are available as to how the aquatic habitat would be altered or whether it is intended to control or eradicate pike. However, the most plausible scenario is that all vegetation would be removed, since adult and juvenile pike prefer heavily vegetated areas of the reservoir.

Submerged, floating, or emergent aquatic vegetation could be removed mechanically or with an aquatic herbicide. By eliminating the preferred habitat, pike would have a difficult time successfully ambushing prey. This option would not eliminate pike but could provide a means to slow the rate of successful reproduction of pike. This method is not a pike eradication method and was not evaluated further.

3.5 WATER LEVEL SCENARIO COMBINED WITH CHEMICAL TREATMENT

These potential alternatives include a water level scenario with a chemical treatment of the reservoir and/or tributaries. Each alternative has a tributary treatment (chemical or non-chemical), application method, formulation and neutralization component. The upstream tributaries would either be physically blocked by a structure or chemicals would be added to block movement of fish. The options are described below.

3.5.1 Dewater Reservoir Completely, Apply Rotenone to Tributaries for One Year and Close Reservoir to Public for a Few Years

This potential alternative was suggested during public scoping. It is assumed that this alternative includes the complete dewatering of the reservoir while the tributaries continue to flow and refill the reservoir. It is also assumed that the reservoir would only need to be dewatered for a minimum length of time (i.e., less than one day, the time required to remove the pike). Rotenone would be applied continuously to the tributaries for one year. The reservoir would be closed for a few years, presumably for the protection of the public health.

Although this option could meet the primary project objective, it failed to pass all of the secondary criteria. This option failed to pass the technical feasibility test. The drawdown scenario indicated that with pumping, the reservoir could be dewatered in one season. However, once it starts to refill, it would be infeasible to run continuous drip stations on all tributaries at all flow rates for an entire year. This alternative is not considered technically feasible because the draining of Lake Davis may not be able to keep up with tributary inflow throughout the year and it is infeasible to operate effective drip stations on the tributaries during high winter flows. Furthermore, there is the potential for substantial impacts to the community and local economy due to the duration of the reservoir closure.

In addition, this method would not meet the criteria to minimize environmental impacts. For an extended period of time, Lake Davis would be closed both to drain and ultimately refill. Human health risks from potential exposure to rotenone formulations over a long duration may be unacceptable. Impacts to biological resources, recreation, and potentially to cultural resources would be substantial. Economic effects on the community would be substantial and the risk of rotenone-bearing surface water being released from Lake Davis accidentally increases with application or rotenone over an extended period of time.

3.5.2 Lower Reservoir to Lowest Level, Apply Rotenone for More Than One Year, and Apply Rotenone to Tributaries (to their source)

This potential alternative was introduced during public scoping. For this evaluation, "lowest level" is assumed to be the same as minimum pool. Rotenone would be applied several times for more than one year to the reservoir as it is filled by the tributaries. It is assumed that the commentor did not intend to maintain the reservoir level at minimum pool. Also, rotenone would be applied to the tributaries up to their headwaters.

This option may meet the objective of pike eradication, but it failed to pass the secondary criteria. It is infeasible for the same reasons stated in the option above.

3.5.3 Drawdown to Minimum Pool, Apply Rotenone to Remaining Water and Tributaries, and Place Barriers Above and Below Reservoir

This potential alternative was introduced during public scoping. It is assumed that this alternative varies from the previous alternative only in that physical barriers are used and chemical barriers are not used. For this alternative, Lake Davis would be drawn down to about 107 acre-feet. The remaining reservoir water and all flowing water from the tributaries would be treated with rotenone.

This alternative has technical feasibility concerns. It is not considered technically feasible because physical barriers on the three major tributaries are not effective during times of high flow. Under high flows the barriers can become flooded. Water flows around the barriers, allowing fish entry to the upper portion of the tributary. Due to the known limitations of barriers, this alternative was not considered further.

3.5.4 Minimum Pool, Apply Rotenone to Remaining Water and Flowing Tributaries

Lake Davis would be drawn down to about 107 acre-feet. The remaining reservoir water and all flowing water from the tributaries would be treated with rotenone.

This option has the ability to meet the project objective is successfully implemented. However, there are feasibility issues associated with treating the minimum pool (107 acre-feet). It would be difficult to deploy a boat in the reservoir at this level and the sediment in the water may reduce the effectiveness of rotenone. Implementation of this alternative would require the use of large pumps and careful reservoir management to achieve this level of drawdown. The pumps would be needed in some water years because the outlet valve could not handle the flow required to get the reservoir down to this level before precipitation patterns began to again refill the reservoir. This alternative would have substantial environmental effects on biological resources, recreation, and possibly on cultural resources. It would also probably have adverse economic consequences for the community of Portola and Plumas County.

3.5.5 Drawdown to 5,000 Acre-Feet, Apply Rotenone to Remaining Water and Flowing Tributaries

Lake Davis would be lowered to approximately 5,000 acre-feet, which is about six percent capacity. The remaining reservoir water and all flowing water from the tributaries would be treated with rotenone.

This option meets the primary project objective and passed the second level criteria. It would have similar impacts to the option described above, but it was proposed for full evaluation in the EIR/EIS.

3.5.6 Drawdown to 20,000 Acre-Feet, Apply Rotenone to Remaining Water and Flowing Tributaries

Lake Davis would be lowered to approximately 20,000 acre-feet, which is about 25 percent capacity. The remaining reservoir water and all flowing water from the tributaries would be treated with rotenone.

This option meets the primary project objective and passed the second level criteria. It would have less severe impacts than the option described above. This alternative was subsequently modified to a drawdown of 15,000 acre-feet to better represent the range of conditions under which the project could be conducted. At that level, it was proposed for full evaluation in the EIR/EIS.

3.5.7 Drawdown to 20,000 Acre-Feet, Apply Two Treatments of Rotenone

This potential alternative was introduced during scoping by a regulatory agency. It is assumed that this potential alternative would be the same as the preceding alternative with the exception of there being a second rotenone treatment and longer period of drawdown. The application of a second treatment to the lake would also extend the period of rotenone use, increases the potential impacts to the affected environment and to the local community, and is unnecessary. A second application was not considered further because of the extended period of treatment and because a single rotenone treatment of lakes can be effective in eliminating an undesirable species of fish when conducted properly. Conducting a second treatment in streams is a standard methodology and is carried forward in all proposed stream treatments.

3.5.8 Maintain 55,000 Acre-Feet volume, Apply Rotenone to Remaining Water and Flowing Tributaries

Lake Davis would be maintained at approximately 55,000 acre-feet, which is 66 percent capacity. The remaining reservoir water and all flowing water from the tributaries would be treated with rotenone.

This option has the potential to meet the project objective of pike eradication. It also passed the secondary criteria with the exception of feasibility. In many years, the reservoir volume in summer is lower than 55,000 acre-feet. It isn't practical or desirable to store water prior to treatment. This level was reduced to 48,000 acre-feet, the level the reservoir was treated in 1997, to evaluate a fuller reservoir option. This alternative with a reservoir volume of 48,000 acre-feet is fully evaluated in the EIR/EIS.

3.6 WATER LEVEL SCENARIO COMBINED WITH NON-CHEMICAL TREATMENT

These potential alternatives include water level scenarios combined with a non-chemical treatment of the reservoir and/or tributaries.

3.6.1 Dewater Reservoir and Tributaries Completely

Lake Davis and all water sources flowing into it would be completely dewatered. Any water-filled depressions within the reservoir footprint, stream channels, overflow areas, or other standing water areas would be drained. These systems would be kept dry long enough to ensure that all pike were eliminated. If feasible, this option would result in the eradication of pike from Lake Davis and tributaries. No chemicals would be applied that require testing. Dewatering reservoirs and tributaries has been conducted at other locations. The technical feasibility of this alternative and its ability to meet the primary objective of pike eradication continues to be studied. The environmental impacts of this alternative will be evaluated in the EIR/EIS.

Impacts to biological resources, recreation, and potentially to cultural resources would be substantial, as would economic effects on the local community. Reservoir drawdown and refill would be accomplished with supplemental pumping and installation of barriers and pipelines. The construction of these will have additional ecological, aesthetic, and cultural impacts. This alternative was selected for inclusion in the EIR/EIS.

3.6.2 Dewater Completely and Screen Inlets and Outflow, Refill in Spring

This potential alternative was introduced during public scoping. DFG is not sure if the commentor intended that both the reservoir and tributaries be dewatered, or only the reservoir. For the purpose of this evaluation, it is assumed that only the reservoir would be dewatered and physical screens would be constructed on the dam and tributary inlets. The reservoir would be allowed to refill in the spring. It is also assumed that the tributaries would not be treated for pike and, therefore, this option would not meet the primary project objective of pike eradication.

3.6.3 Lower Water Levels During Spawning, Net or Electrofish to Get Pike Out

This potential alternative was introduced during public scoping. The commentor did not specify what water-level scenario was being recommended. Pike would be removed using either netting or electrofishing methods. The intent would be to remove the pike during spawning when they are more vulnerable to capture. It is assumed that the netting or electrofishing methods would also be applied to the tributaries. Netting and electrofishing methods are discussed in 3.3.1. This option would not meet the primary project objective of pike eradication.

Six project alternatives were selected from those evaluated as part of the Phase II assessment process. These six alternatives are to be further evaluated in the EIR/EIS. Each of these alternatives involves Lake Davis being maintained or drawn down to volumes of 48,000, 35,000, 15,000 and 5,000 acre-feet by August 2007. Five of these alternatives involve rotenone treatment, primarily a liquid formulation, but one with a powdered formulation for the reservoir. The sixth alternative is the complete dewatering of the reservoir and its tributaries without chemical treatment. In addition, the EIR/EIS will examine a seventh alternative that is the No Project alternative. A summary of each alternative is provided below.

4.1 48,000 ACRE-FEET PLUS ROTENONE

Under this alternative the reservoir would be at 48,000 acre-feet and liquid rotenone would be applied throughout the reservoir; to reservoir shoreline areas; to tributary streams; and to any pools, ponds, or springs in the watershed potentially containing pike. This alternative differs from the other alternatives in the amount of time required for drawdown, the resulting surface area and volume of the reservoir, the length of the tributary streams to be treated, the resulting amount of rotenone required, and the project duration (time from commencement of drawdown through the treatment period). Because the reservoir would be at 48,000 acre-feet, no drawdown or refill operations would be required. At a volume of 48,000 acre-feet, the surface elevation of Lake Davis is about 5,764 feet, and the surface area is about 2,936 acres. This alternative would permit full boat access to the reservoir, as all ramps would be functional. It is similar to the level of the reservoir for the previous treatment in 1997, and has the highest probability of being accomplished in all water years by August 1.

4.2 35,000 ACRE-FEET PLUS ROTENONE

Under this alternative the reservoir would be drawn down to 35,000 acre-feet and liquid rotenone would be applied throughout the reservoir; to reservoir shoreline areas; to tributary streams; and to any pools, ponds, or springs in the watershed potentially containing pike. The main differences between this alternative and the 15,000 acre-feet and 5,000 acre-feet alternatives are: the amount of time required for drawdown, the resulting reservoir size (both surface area and volume), the length of the tributary streams to be treated, the resulting amount of rotenone required, and the project duration, which includes the time from commencement of drawdown through the treatment period, until Lake Davis is refilled to a 45,000 acre-foot level. At a volume of 35,000 acre-feet, the surface elevation of Lake Davis is about 5,760 feet and the surface area is about 2,439 acres. This alternative represents a limited recreation alternative. Under this alternative, the boat ramp at Honker Cove could be extended to allow boat access to the reservoir. The other three boat ramps would not be usable.

4.3 15,000 ACRE-FEET PLUS 2 ROTENONE OPTIONS

Two alternatives involve the drawdown of the reservoir to 15,000 acre-feet, but differ in the type of rotenone treatment.

4.3.1 Liquid Rotenone in Reservoir and Tributaries

Under the this alternative, the reservoir would be drawn down to 15,000 acre-feet and a liquid rotenone formulation would be applied throughout the open water of the reservoir, to the reservoir shoreline areas, to tributary streams, and to any pools, ponds, or springs in the watershed potentially containing northern pike. With a volume of 15,000 acre-feet, the surface elevation of Lake Davis is about 5,749 feet and the surface area is about 1,331 acres.

4.3.2 Powdered Rotenone in Reservoir, Liquid in Tributaries

This alternative is similar to the liquid rotenone (above) except a powdered form of rotenone would be used in the reservoir, and liquid rotenone (Noxfish or CFT Legumine) would be applied to the tributary streams, pools, ponds, or springs in the watershed that could contain pike. This alternative was selected to evaluate the use of powdered rotenone, which does not contain solvents, mixing agents or emulsiers and has no potential for odor. However, the use of powdered rotenone creates more of a hazard for applicators and resources needed for applicator safety.

4.4 5,000 Acre-Feet Plus Rotenone

Under this alternative, the reservoir would be drawn down to 5,000 acre-feet and liquid Noxfish or CFT Legumine would be applied throughout the reservoir; to tributary streams; and to any pools, ponds, or springs in the watershed potentially containing pike. At a volume of 5,000 acre-feet, the surface elevation of Lake Davis is about 5,738 feet and the surface area is about 550 acres. The project would begin with reservoir drawdown starting in January 2007, followed by rotenone application between mid August and ate October of 2007. This alternative was selected for evaluation because the environmental concerns are similar to the dead pool concept of drawdown to 107 acre-feet, but this alternative is more feasible because it would take less time to achieve the target drawdown volume.

4.5 Dewater Reservoir and Tributaries (no Chemical treatment)

Under this alternative, the eradication of pike from Lake Davis would be attempted by completely draining the reservoir and all water sources flowing into it. Any water-filled depressions within the reservoir footprint, stream channels, overflow areas, or other standing water areas would be drained. Generally, the dewatering of streams and lakes is a proven and effective method to kill fish. However, the feasibility of dewatering streams on this scale and setting is questionable and needs further information and evaluation if feasible. These systems would be kept dry long enough to eliminate all pike. Under this alternative, no piscicides would be used, and there would be no potential risks to human health and the environment, including terrestrial species from rotenone. Other risks of dewatering to terrestrial and aquatic species are evaluated in the EIR/EIS.

4.6 No Project Alternatives

The EIR/EIS must discuss a No Project or No Action Alternative, which is the baseline for the NEPA effects analysis. DFG already engages in control and containment activities to manage the pike population in Lake Davis. The No Project Alternative is the continuation of current management activities.

This option includes the continuation of the existing reservoir and fishery management practices as of September 2005 into the foreseeable future. The goal of the current plan is to control the population of northern pike in Lake Davis and keep the pike contained in the reservoir. The implementation strategy includes several recommendations outlined in the *Y2000 Plan* (Save Lake Davis Task Force Steering Committee and DFG 2000) and the *Managing Northern Pike at Lake Davis, A Plan for Year 2000: Three Year Report* (referred to as *Y2000 Plan*: Three Year Report) (DFG 2003). Because the *Y2000 Plan* encourages "an adaptive approach that is responsive to changes," control and containment measures beyond those specifically recommended in the *Y2000 Plan* may be proposed and implemented under the plan. Such measures could potentially include control and containment options suggested during public scoping that do not meet the project purpose and objective of pike eradication. These options include fishing derbies and other population reduction tools. In addition to implementing the *Y2000 Plan*, the DFG continues to work with the DWR to reduce chances of reservoir spill. There would be no forest closure, and recreation activity would continue similar to recent years.

California Department of Fish and Game (DFG). 2000. *Managing Northern Pike at Lake Davis, A Plan for Y2000.* Prepared by the Save Lake Davis Task Force Steering Committee and California Department of Fish and Game. February.

DFG. 2003. *Managing Northern Pike at Lake Davis, A Plan for Year 2000: ThreeYear Report*. September.

DFG. 2004. *Lake Davis Northern Pike Eradication Options*. May 24.

DFG. 2006.

DFG and U.S. Forest Service. 2006. *Final Scoping Report for the Proposed Lake Davis Pike Eradication Project*. February.

Moyle, P.B. 2002. Inland Fishes of California. University of California Press, Berkeley, California.

APPENDIX A

ALTERNATIVE SELECTION PROCESS

OPTION ASSESSMENT

The options were compiled from DFG staff, suggestions by experts and regulatory staff from other agencies, universities, private consulting companies, local officials, and private citizens. The options suggested were evaluated using a two-phased assessment approach, which considered each of the options identified. The options were reviewed to determine if they would accomplish the primary objective of the project to eradicate pike from Lake Davis and its tributaries. The options that meet this criterion were then evaluated against the second level criteria. These included the following factors: protection of public health and safety; timely implementation; use of a proven, effective method; compliance with applicable laws; technical feasibility; and minimization of environmental impacts. Once the options were evaluated against these criteria, alternatives were formulated from options that best met the project objectives.

Phase I Assessment Objectives

The potential options for alternatives were evaluated during Phase I to establish whether they met the primary objective of successfully eradicating pike from Lake Davis and its tributaries. If the potential alternative could not achieve that objective, then it was eliminated from consideration for inclusion in the reasonable range of alternatives to be analyzed in detail in the EIR/EIS. If a potential alternative met this primary objective, or if more information was needed to determine if it could meet this primary objective, the potential alternative was not eliminated at Phase I, but was further evaluated under Phase II.

Selection of Alternatives

Each option or potential alternative identified was evaluated relative to its likelihood of achieving the primary objective of successfully eradicating pike from Lake Davis and its tributaries during Phase I of the assessment. The results of this evaluation are presented in Table A-1 with the rationale for elimination provided in the text. All of the alternatives included in the "water level scenarios combined with chemical treatment" either met the primary objective or required more information to make the determination. The only other potential alternative that was considered to meet the primary objective of eradicating pike in Lake Davis and its tributaries or to need more information to make that determination was the complete dewatering of Lake Davis and its tributaries.

Table A-1. Results of Phase I Assessment Process

Alternative	Would this Alternative be Effective at Eradicating Pike from Lake Davis and its Tributaries?	Notes/Comments
No Action Alternative		
No Action, Discontinue Current Control and Containment Program	No	
No Action, Maintain Current Control and Containment Program	No	The *Three Year Report* (DFG 2003) has shown that pike population has increased and this option does not reduce the risk of pike escapement.
Water-Level Scenario Combined with Chemical Treatment		
Dewater Reservoir Completely, Apply Rotenone to Tributaries for 1 Year, and Close Reservoir to Public for Few Years	Yes	If implementable, this alternative could eradicate pike in Lake Davis.
Lower Reservoir to Lowest Level, Apply Rotenone to Remaining Water for >1 Year, and Apply Rotenone to Tributaries (to their source)	Yes	This alternative could eradicate pike in Lake Davis if successfully implemented.
Minimum Pool, Apply Rotenone to Remaining Water and Tributaries, and Place Barriers Above and Below Lake	Yes	This alternative could eradicate pike in Lake Davis if successfully implemented.
Minimum Pool, Apply Rotenone to Remaining Water and Flowing Tributaries	Yes	This alternative could eradicate pike in Lake Davis if successfully implemented.
Minimum Pool, Apply Antimycin to Remaining Water and Flowing Tributaries	Yes	This alternative could eradicate pike in Lake Davis if successfully implemented.
Minimum Pool, Apply Copper Sulfate to Remaining Water and Flowing Tributaries	Need More Information	It appears that this alternative could eradicate pike in Lake Davis if successfully implemented. However, more data is required to assess its effectiveness as a piscicide for northern pike.
Minimum Pool, Apply Chlorine to Remaining Water and Flowing Tributaries	Need More Information	It appears that this alternative could eradicate pike in Lake Davis if successfully implemented. However, more data is required to assess its effectiveness as a piscicide for northern pike.
Minimum Pool, Apply Chloramine to Remaining Water and Flowing Tributaries	Need More Information	It appears that this alternative could eradicate pike in Lake Davis if successfully implemented. However, more data is required to assess its effectiveness as a piscicide for northern pike.
Nearly Empty, Apply Rotenone to Remaining Water and Flowing Tributaries	Yes	This alternative could eradicate pike in Lake Davis if successfully implemented.
Nearly Empty, Apply Antimycin to Remaining Water and Flowing Tributaries	Yes	This alternative could eradicate pike in Lake Davis if successfully implemented.

Table A-1. Results of Phase I Assessment Process

Alternative	Would this Alternative be Effective at Eradicating Pike from Lake Davis and its Tributaries?	Notes/Comments
Drawdown to 5,000 AF, Apply Copper Sulfate to Remaining Water and Flowing Tributaries	Need More Information	It appears that this alternative could eradicate pike in Lake Davis if successfully implemented. However, more data is required to assess its effectiveness as a piscicide for northern pike.
Drawdown to 5,000, Apply Chlorine to Remaining Water and Flowing Tributaries	Need More Information	It appears that this alternative could eradicate pike in Lake Davis if successfully implemented. However, more data is required to assess its effectiveness as a piscicide for northern pike.
Drawdown to 5,000, Apply Chloramine to Remaining Water and Flowing Tributaries	Need More Information	It appears that this alternative could eradicate pike in Lake Davis if successfully implemented. However, more data is required to assess its effectiveness as a piscicide for northern pike.
Drawdown to 20,000 AF, Apply Rotenone to Remaining Water and Flowing Tributaries	Yes	This alternative could eradicate pike in Lake Davis if successfully implemented.
Drawdown to 20,000 AF, Apply Two Treatments of Rotenone while Leaving Reservoir Drained for a Longer Period	Yes	This alternative could eradicate pike in Lake Davis if successfully implemented.
Drawdown to 20,000 AF, Apply Antimycin to Remaining Water and Flowing Tributaries	Yes	This alternative could eradicate pike in Lake Davis if successfully implemented.
Drawdown to 20,000 AF, Apply Copper Sulfate to Remaining Water and Flowing Tributaries	Need More Information	It appears that this alternative could eradicate pike in Lake Davis if successfully implemented. However, more data is required to assess its effectiveness as a piscicide for northern pike.
Drawdown to 20,000 AF, Apply Chlorine to Remaining Water and Flowing Tributaries	Need More Information	It appears that this alternative could eradicate pike in Lake Davis if successfully implemented. However, more data is required to assess its effectiveness as a piscicide for northern pike.
Drawdown to 20,000 AF, Apply Chloramine to Remaining Water and Flowing Tributaries	Need More Information	It appears that this alternative could eradicate pike in Lake Davis if successfully implemented. However, more data is required to assess its effectiveness as a piscicide for northern pike.
Maintain at 55,000 AF, Apply Rotenone to Remaining Water and Flowing Tributaries	Yes	This alternative could eradicate pike in Lake Davis if successfully implemented.
Maintain at 55,000 AF, Apply Antimycin to Remaining Water and Flowing Tributaries	Yes	This alternative could eradicate pike in Lake Davis if successfully implemented.

Table A-1. Results of Phase I Assessment Process

Alternative	Would this Alternative be Effective at Eradicating Pike from Lake Davis and its Tributaries?	Notes/Comments
Maintain at 55,000 AF, Apply Copper Sulfate to Remaining Water and Flowing Tributaries	Need More Information	It appears that this alternative could eradicate pike in Lake Davis if successfully implemented. However, more data is required to assess its effectiveness as a piscicide for northern pike.
Maintain at 55,000 AF, Apply Chlorine to Remaining Water and Flowing Tributaries	Need More Information	It appears that this alternative could eradicate pike in Lake Davis if successfully implemented. However, more data is required to assess its effectiveness as a piscicide for northern pike.
Maintain at 55,000 AF, Apply Chloramine to Remaining Water and Flowing Tributaries	Need More Information	It appears that this alternative could eradicate pike in Lake Davis if successfully implemented. However, more data is required to assess its effectiveness as a piscicide for northern pike.
Water-Level Scenario Combined with Non-Chemical Treatment		
Dewater reservoir and Tributaries Completely	Need More Information	This alternative could eradicate pike in Lake Davis if feasible and successfully implemented. A closer examination of this option is required.
Dewater Completely and Screen Inlets and Outflow, Refill in Spring	No	This alternative would not eradicate pike from tributaries.
Lower Water Levels During Spawning; Net or Electrofish to Get Pike Out	No	This alternative would not remove every pike from the reservoir and tributaries.
Other Alternatives with Non-Chemical Treatment		
Destratify reservoir by Adding Pure Nitrogen into Bottom of reservoir	No	This alternative would not eradicate pike from tributaries.
Alter Aquatic Habitat by Increasing Nutrient Load	No	This alternative would not eradicate pike from tributaries.
Add Carbon Dioxide Under Winter Ice	No	This alternative would not eradicate pike from tributaries.
Alter Aquatic Habitat of the Entire reservoir	No	This alternative would not eradicate pike from the reservoir and tributaries.
Increase Current Pike Management Methods of Control and Containment	No	This alternative is considered management of pike and would not eradicate pike in the reservoir or tributaries.
Introduce Another Predator Fish	No	This is considered management of pike and would not eradicate pike in the reservoir or tributaries.
Attach Capsules to Prey Fish With : Poison, Anesthetic, Sterilizer, or Intestinal Blocker	No	This is considered management of pike and would not eradicate pike in the reservoir or tributaries. Small pike could be missed.
Net Spawning Females	No	This is considered management of pike and would not eradicate pike in the reservoir or tributaries.

Table A-1. Results of Phase I Assessment Process

Alternative	Would this Alternative be Effective at Eradicating Pike from Lake Davis and its Tributaries?	Notes/Comments
Use Navy Whale Killing Sonar	No	No information is available to indicate that this method would be effective at eradicating pike.
Use Heat to Gather Pike and Kill Them	No	This is considered management of pike and would not eradicate pike in the reservoir or tributaries. Also, no information is available to indicate that this method would be effective at eradicating pike.
Fish-Out Alternatives:		
Fish Tournament with No Restriction on Size, Quantity, Age and Sex of Pike	No	This alternative would not eradicate pike in the reservoir or its tributaries because there are portions of the pike population that are not vulnerable to fishing, such as undersized pike.
Hold Fish Derbies with Bounties	No	This alternative would not eradicate pike in the reservoir or its tributaries because there are portions of the pike population that are not vulnerable to fishing, such as undersized pike.
Hold Fish Derby Contests for Most Pike Caught, Largest Pike Caught, Smallest Pike Caught	No	This alternative would not eradicate pike in the reservoir or its tributaries because there are portions of the pike population that are not vulnerable to fishing, such as undersized pike, and it is extremely unlikely that all the adult pikes could be fished out.
Hold BBQ's with Free Pike on Menu	No	This alternative would not eradicate pike in the reservoir or its tributaries because there are portions of the pike population that are not vulnerable to fishing, such as undersized pike.
Hold "How to Fish for Pike" Clinics	No	This alternative would not eradicate pike in the reservoir or its tributaries because there are portions of the pike population that are not vulnerable to fishing, such as undersized pike.
DFG Announce Free Fishing for 30 Days and Then Drain the Reservoir	No	This alternative would not eradicate pike in the reservoir or its tributaries because there are portions of the pike population that are not vulnerable to fishing, such as undersized pike.
Place a Bounty on Dead Pike Carcasses	No	This alternative would not eradicate pike in the reservoir or its tributaries because there are portions of the pike population that are not vulnerable to fishing, such as undersized pike.
Fish Out the Lake and Use Pike as Fertilizer	No	This alternative would not eradicate pike in the reservoir or its tributaries because there are portions of the pike population that are not vulnerable to fishing, such as undersized pike.
Fish Out the Lake and Introduce Catfish to Eat Young Pike	No	This is considered management of pike and would not eradicate pike in the reservoir or tributaries. In addition, catfish would not likely stay in the tributaries.

Table A-1. Results of Phase I Assessment Process

Alternative	Would this Alternative be Effective at Eradicating Pike from Lake Davis and its Tributaries?	Notes/Comments
Hold a Spearfishing Contest	No	This alternative would not eradicate pike in the reservoir or its tributaries because there are portions of the pike population that are not vulnerable to fishing, such as undersized pike.

The remaining potential alternatives were eliminated because they were determined not to be effective at eradicating pike. Most of these alternatives either did not provide a project component that would eradicate pike from the tributaries (e.g., destratify reservoir, applying carbon dioxide, etc.) or were fish management alternatives (e.g., fish-out alternatives, net spawning females, using heat to gather pike, etc.) that would impact the pike population, but not likely result in pike eradication. If pike are not eradicated from the tributaries simultaneously to eradication measures taken at Lake Davis, then pike could repopulate the reservoir upon completion of eradication measures at Lake Davis. Because fish management measures currently employed at Lake Davis have not been effective to date, it is unlikely that similar methods would have significantly greater success. Other fish management alternatives such as introducing another predator or attaching capsules to prey fish were also determined to be alternatives that would not achieve the objective of the eradication of pike.

PHASE II ASSESSMENT OBJECTIVES

As described previously in Section 2, potential alternatives were evaluated during Phase II to establish whether they met the following project objectives:

- Can be used in a manner that protects public health and safety;
- Can be carried out quickly to reduce the ongoing risk that pike will escape the reservoir and spread to downstream waters;
- Is a method that has been proven to be effective in laboratory and field experiments;
- Is in compliance with applicable laws;
- Is a method that is technically feasible to implement; and
- Minimizes environmental impacts.

Selection of Alternatives

For the potential alternatives that met the primary objective of eradicating pike from Lake Davis and its tributaries, or if more information was needed to determine if it could meet this primary objective, the potential alternative was not eliminated at Phase I, but was further

evaluated under Phase II based on the Phase II assessment criteria. The results of this evaluation are described below and summarized in Table A-2.

Table A-2. Phase II Determination of Alternatives Meeting Multiple Objectives

Alternative	Can be used in a manner that protects public health and safety?	Can be carried out quickly to reduce the ongoing risk that pike will escape the reservoir and spread to downstream waters?	Is a method that has been proven to be effective in laboratory and field experiments?	Is in compliance with applicable laws?	Is a method that is technically feasible to implement?	Minimizes environmental impacts (e.g., decreases recreational impacts, cultural resource exposure impacts, and economic impacts)?
Water Level Scenario combined with Chemical Treatment:						
Dewater Reservoir Completely, Apply Rotenone to Tributaries for 1 year, and Close Reservoir to Public for Few Years	No	No	No	Yes	No	No
Lower Reservoir to Lowest Level, Apply Rotenone to Remaining Water for >1 Year, and Apply Rotenone to Tributaries (to their source)	Yes	Yes	Yes	Yes	Yes	No
Minimum Pool, Apply Rotenone to Remaining Water and Tributaries, and Place Barriers Above and Below Lake	Yes	Yes	Yes	Yes	No	No
Minimum Pool, Apply Rotenone to Remaining Water and Flowing Tributaries	Yes	Yes	Yes	Yes	Yes	No

Table A-2. Phase II Determination of Alternatives Meeting Multiple Objectives

Alternative	Can be used in a manner that protects public health and safety?	Can be carried out quickly to reduce the ongoing risk that pike will escape the reservoir and spread to downstream waters?	Is a method that has been proven to be effective in laboratory and field experiments?	Is in compliance with applicable laws?	Is a method that is technically feasible to implement?	Minimizes environmental impacts (e.g., decreases recreational impacts, cultural resource exposure impacts, and economic impacts)?
Drawdown to 5,000 AF, Apply Rotenone to Remaining Water and Flowing Tributaries	Yes	Yes	Yes	Yes	Yes	No
Drawdown to 20,000 AF, Apply Rotenone to Remaining Water and Flowing Tributaries	Yes	Yes	Yes	Yes	Yes	No
Drawdown to 20,000 AF /Two Treatments of Rotenone while Leaving Reservoir Drained for a Longer Period	Yes	Yes	Yes	Yes	Yes	No
Maintain at 55,000 AF, Apply Rotenone to Remaining Water and Flowing Tributaries	Yes	Yes	Yes	Yes	Yes	Yes
Water-Level Scenario Combined with Non-Chemical Treatment						
Dewater Reservoir and Tributaries Completely	Yes	Need Further Evaluation	Yes	Yes	Need Further Evaluation	No